TECHNICAL REPORT TO THE NEW YORK STATE IPM GRANTS PROGRAM

Title: Reducing Damage from Potato Leafhoppers on Alfalfa in New York through Cultivar Selection: A Comparison of Resistant vs. Susceptible Cultivars under Insecticide Treatment and No Treatment (Year 2).

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Abstract:

The more advanced generations of alfalfa (*Medicago sativa* L.) cultivars and experimentals resistant to potato leafhopper (PLH), *Empoasca fabae* (Harris), were released in 1998 and planted at Ithaca that year. Cultivars released in 1999 were planted in a separate trial in spring of 1999. The trial design is a split-plot with the main plots as insecticide treatment vs. no treatment. In 2000, PLH populations were above threshold in both trials on 26 July, 10 days prior to harvest 2; however, insect populations were below threshold at second harvest. In the trial planted in 1999, first harvest yield data indicated a carryover effect showing that plots which had received spray treatment in 1999, and thus much less PLH damage, were higher yielding in 2000, relative to plots unsprayed in 1999. Similarly, the 1999-unsprayed resistant entries yielded more in 2000 than 1999-unsprayed susceptible entries, again likely because of PLH damage in the seeding year carrying over and affecting the susceptible entries in 2000. At second and third harvests of this trial, however, the resistant entries yielded less than the susceptible ones. The carryover effect was not seen in the trial planted in 1998, probably because this trial had received PLH damage in its first production year, not in the more sensitive seeding year. In the trial planted in 1998, first and second harvest data showed that the resistant entries often yielded slightly less than than the susceptibles regardless of spray treatment, and at third harvest, the resistant entries yielded significantly less than the susceptible ones in both the sprayed and unsprayed treatments. At second harvest of this trial, when PLH damage was evident, the unsprayed susceptible entries were more damaged by the PLH than the unsprayed resistant entries, which were in turn more damaged than the sprayed susceptible entries.

Background and Justification:

Alfalfa is one of the most important forage crops grown in New York, and PLH is the most damaging insect pest of alfalfa in the Northeast. Risk from PLH can be expected annually; however, actual severity of infestations is variable year to year and county to county.

At Ithaca in 1998 and 1999, seed companies entered PLH-resistant cultivars and experimentals into the Cornell Forage Project yield trials. The PLH-resistant cultivars are listed in Cornell Recommends. For these trials, ten replications were planted, five of which were randomly assigned to receive insecticide treatments to eliminate PLH

populations, and five were assigned as untreated and thus susceptible to damage by PLH in some years.

In 1999, PLH populations went above threshold immediately prior to harvest 2 (28 July) in both the first production year and seeding year trials (Hansen *et al*., 2000). Yields in these trials were reduced overall due to severe drought. In the seeding year trial, plots in the sprayed treatment had negligible PLH adults, fewer nymphs, and lower PLH damage scores than plots in the unsprayed treatment; however, the differences in yield noted visually were not statistically significant. In the first production year trial, plots in the sprayed treatment had fewer PLH adults, nymphs, lower PLH damage scores, and higher percent bloom and yield than plots in the unsprayed treatment. In both the seeding year and first production year trials, the unsprayed resistant entries had lower yield, higher forage quality, and lower value per acre (-$15/acre seeding year, -$24/acre first production year) than the sprayed susceptible entries.

The 1999 growing season was extremely dry in New York, and the drought heavily impacted the yields of the trials at Ithaca. As a result, we did not see the resistant cultivars outyield the susceptibles as we have previously under PLH pressure in unsprayed trials; however, comparisons related to PLH characteristics (adult counts, nymphs, and PLH damage scores) consistently showed the superiority of the PLH-resistant cultivars when PLH are present. We suspect that the resistant entries, were it not for the severe drought, likely would have outyielded the susceptible entries under unsprayed conditions with the PLH pressure that we had at harvest 2. It may be that the few PLH that survived on the resistant entries were as damaging to the alfalfa under prolonged dry conditions as were many PLH on the susceptible entries. Thus, in 2000, we repeated the 1999 experiment to document the resistant versus susceptible and sprayed vs. unsprayed comparisons under more normal weather conditions.

Objectives:

1. Compare PLH-resistant cultivars and experimentals with susceptible alfalfa cultivars for PLH damage and yield in the first and second production years under natural populations of PLH in Ithaca. Similarly, compare the resistant and susceptible cultivars for yield and agronomic characteristics when insecticides have eliminated PLH.

2. Compare PLH-resistant and susceptible alfalfa cultivars and experimentals for forage quality and nymph populations at one harvest where PLH damage is greatest.

Materials and Methods:

Both the 1998-planted and 1999-planted trials were assessed for percent stand on 14 April. Lodging notes on the trial planted in 1998 were taken on 16 June and 7 August (just prior to harvests 1 and 2, respectively), using a scale where 1 = least lodging and 3 = most lodging (16 June rating scale), or 1 = least lodging and 4 = most lodging (7 August rating scale). Also on that same trial, maturity notes were taken using a 1 = least, 9 = most scale

just prior to harvest 2. Adult PLH counts were taken (total number of adults per 10 sweeps per rep) throughout the summer.

In order to measure yield, 3' x 13' (.0009A) plots were harvested with a Carter harvester, a flail-type mower. Forage was collected in canvas bags and weighed on a digital hanging scale. Every fifth plot was sub-sampled for dry matter determinations. The trial planted in 1998 (second production year) was harvested three times, 16 June, 7 August, and 22 September. The trial planted in 1999 (first production year) was harvested three times, 19 June, 1 August, and 22 September. Prior to second harvest of the trial planted in 1998, the plots were rated for PLH damage using the recommended rating scale of 1-5 where 1 = no apparent injury, 2 = very minor stunting and yellowing, 3 = moderate stunting, yellowing evident on 20-40% of leaves, 4 = significant injury with stunting and yellowing on 40-60% of leaves, and 5 = severe injury with severe stunting and yellowing on 60-100% of leaves (McCaslin and Miller, 1996).

Spray treatments were made using Warrior T insecticide (3 fl.oz/A) (ZENECA Ag Products, ZENECA Inc., Wilmington, DE 19850-5458) on 29 June, 17 July, and 21 August. In each of the two trials, five replicates were treated and five were left untreated.

Samples for forage quality and nymph counts were taken on 7 August, just prior to second harvest, from the trial planted in 1998 since only the 1999 trial showed minimal PLH damage. Rather than take composite samples for forage quality, we decided to do plot-by-plot sampling. The samples for forage quality analysis of about 300-500 grams fresh weight were taken from plots in three sprayed replicates and three unsprayed replicates. The samples were dried for three or more days at 55°C. The dried samples were weighed, ground through a Wiley mill (2 mm screen), subsampled, and then reground through a Udy mill (1 mm screen). The forage quality data were determined by applying the universal equation to the near infrared reflectance spectral (NIRS) data for each sample. The forage quality data predicted were percent crude protein, percent acid detergent fiber, percent neutral detergent fiber, and relative feed value. The forage quality data were entered into the FORVAL program (Wilkens and Fick, 1988) to determine price per ton of hay. The hay prices were multiplied by yield to give dollar value per acre per entry. The default values of the FORVAL program were used to compute price per ton of hay, except for corn grain ($2.69/bu) and soybean meal ($210/ton), prices from 27 November 2000.

Nymph counts per stem were determined by carefully cutting 10 stems per plot and placing them in plastic bags. The bags were stored in a 5°C cooler, and nymph counts were determined within two days after collecting.

The data were analyzed using PROC MIXED in SAS (Littell *et al*., 1996). Nonorthogonal contrasts (spray vs. no-spray, resistant vs. susceptible within sprayed treatment, resistant vs. susceptible within unsprayed treatment, resistant unsprayed vs. susceptible sprayed) were tested for statistical significance.

Results:

Rainfall The accumulated precipitation for the Ithaca growing season, April-October 2000, was 26.35 inches, 113% of normal (North East Regional Climate Center, Cornell University). It was particularly wet in April, May and June.

Insect Pressure (Table 1, Appendix 1) The insect pressure in Ithaca 10 days prior to second harvest was above threshold in all unsprayed replicates of the 1999 trial, and in replicates 5 (Appendix 1) and 8 of the 1998 trial. However, at second harvest (7 August, 1 August for the 1998, 1999 trials, respectively) the PLH populations were not above threshold.

Ithaca First Production Year Trial (Agronomic Characteristics and Yield) (Table 2) Damage by PLH was not evident on this trial in 2000, thus the plots were not sampled for nymphs and forage quality. In spring 2000, stand notes were taken to assess any differences in winter survival among the treatments and trial entries. The overall percent stand for the trial was 93.5%. The only significant difference noted was in the sprayed treatment where the resistant entries had significantly lower stand (92%) compared to the susceptible entries (95%). This difference was not seen in the unsprayed plots.

At first harvest, the sprayed plots yielded more than the unsprayed plots, even though the first spray treatment in 2000 was on 6/29 when there were negligible numbers of PLH present during the first harvest interval. It is likely that this yield difference is due to a carryover effect from 1999, when the unsprayed plots in the seeding year were severely damaged by PLH and the sprayed plots were not. Similarly, the unsprayed resistant entries yielded 0.27 tons/acre dry matter more than the unsprayed susceptible entries at first harvest. At second and third harvests, the resistant entries tended to yield less than the susceptible entries, regardless of the spray treatment. At all three harvests, the unsprayed resistant entries yielded less than the sprayed susceptible entries.

Ithaca Second Production Year Trial (Agronomic Characteristics and Yield) (Tables 3 and 4) The overall percent stand for the trial was 96.8%. The resistant entries had small but statistically significantly lower percent stand than the susceptible entries, regardless of spray treatment. At first and second harvest, notes on lodging were taken. At first harvest planned comparisons were not statistically significant, whereas at second harvest, the sprayed entries lodged more than the unsprayed entries. Also, both the sprayed and unsprayed susceptible entries lodged more than the unsprayed resistant entries. None of the lodging comparisons were associated with differences in yield. At harvest 2 (7 August), the spray treatment effectively protected both the resistant and susceptible entries from PLH damage. The unsprayed susceptible entries were damaged by PLH more than the unsprayed resistant entries, and the unsprayed resistant entries were damaged by PLH more than the sprayed susceptible entries. Similar trends were seen with the nymph count data, except that both the resistant and susceptible unsprayed entries supported a small number of nymphs per 10 stems, even though the PLH damage scores were lower for the unsprayed resistant entries. These low nymph numbers, on both the resistant and susceptible unsprayed entries, are likely reflective of the low overall number of adult PLH seen on the plots at harvest 2 (Table 1).

In 2000, spraying insecticide did not result in higher yields at any of the three harvests and the season total. At first and second harvests and over the total season, most of the resistant vs. susceptible comparisons were not statistically significant, regardless of spray treatment. However within each spray treatment, the resistant entries were often slightly lower in yield than the susceptible entries. In the unsprayed plots at harvest 2, we expected to see yield differences among the resistant and susceptible entries, because the PLH had gone above threshold 10 days before harvest and because we were able to visually assess PLH damage differences among the plots at harvest 2 (7 August). However, the number of adult PLH had dropped off to below-threshold levels at the 31 July sampling date, and the PLH feeding between 26 July, when they were above threshold, and second harvest on 7 August was apparently not enough to affect yield. At third harvest, the resistant entries yielded significantly less than the susceptible entries within both the sprayed and unsprayed treatments. Third harvest was not taken until September 22, and it may be that the resistant entries are more fall dormant than the susceptible entries in this trial.

Ithaca Second Production Year Trial (Forage Quality) (Table 5) Similar to the data from 1999, the resistant entries had significantly higher crude protein than the susceptible entries regardless of the spray treatment. Within a spray treatment, the resistant entries did not differ from the susceptible entries in percent fiber, relative feed value or dollar value per acre. However the unsprayed resistant entries had significantly lower percent crude protein, percent fiber (ADF and NDF), and higher relative feed value than the sprayed susceptible entries. Once again, the higher quality values for the resistant entries were associated with forage at a slightly earlier maturity stage (Table 3).

Conclusions:

Following several mild winters in New York, the PLH-resistant cultivars have not shown any reduced winterhardiness relative to the susceptible cultivars. However, the PLH-resistant cultivars have shown slightly reduced percent stand and less fall growth when compared to the susceptible cultivars. These differences may be due to other attributes such as disease resistance and fall dormancy, respectively.

Severe damage by PLH in the seeding year can carryover and result in reduced yields in the first production year as was seen in the 1999 (Hansen *et al*., 2000) and the 1997 (Hansen *et al*., 1998) seedings in Ithaca. In the seeding year, the resistant cultivars, although showing much reduced PLH damage compared to unsprayed susceptible cultivars, are still susceptible to PLH damage particularly when some other environmental condition such as drought stresses the plants (Hansen *et al*., 2000). A grower may have to spray a resistant cultivar in the seeding year if PLH numbers are very heavy, and/or soil moisture is limiting.

The PLH-resistant cultivars were developed by introducing wild germplasm into cultivated alfalfa; in the process, genes for improved forage quality characteristics appear to have been introduced as well. In all cases where quality samples were taken, the resistant cultivars had higher percent crude protein than the susceptible cultivars. Additionally the resistant cultivars were earlier in maturity than the susceptible cultivars.

In the presence of damaging levels of PLH adults and nymphs in a no-spray trial, the resistant cultivars always had lower PLH damage scores than the susceptible cultivars, and usually had lower nymph counts. The resistant cultivars truly show some resistance, but are not immune to PLH damage.

Yield of the second generation of resistant cultivars was usually comparable to yield of susceptible cultivars when damage from PLH was not a concern. Yield of resistant cultivars is usually higher than susceptible cultivars when PLH populations are high. However, in comparisons of sprayed susceptible cultivars with unsprayed resistant cultivars, the sprayed susceptible cultivars usually are higher yielding. It seems that timely spraying is better protection to alfalfa seedings than planting resistant cultivars, and the resistant cultivars in production year trials can be damaged by PLH if the plants are stressed in other ways such as low available soil moisture.

The relative risk of PLH damaging a New York alfalfa field can vary year to year and, in a given year, may even vary among fields on a farm. To avoid potential PLH-induced losses, growers are encouraged to monitor alfalfa fields weekly, beginning after first harvest and continuing through first frost. If PLH populations are sufficient to justify management action, fields can be harvested early, if within one week of scheduled harvest, or may require an insecticide spray. If a producer does not want to spray, does not want to invest in chemicals or hire commercial pesticide applicators, or cannot spray all acreage in a timely manner, then planting PLH-resistant cultivars is an alternative that allows the producer to reduce but not eliminate, the risk of yield loss due to PLH damage.

Literature Cited:

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Table 1. 2000 PLH sampling data from first and second production year spray vs. no spray trials in Ithaca, NY

			No Spray (5 Reps)		**Spray (5 Reps)**	
Trial	**2000 Sample Date**	**Height (inches)**	**Avg. Number PLH per sweep**	**Above Threshold?**	**Avg. Number PLH per sweep**	**Above Thresh-old?**
Second Production Year Trial (planted 4/30/98)						
	7/5/00	**8 - 12 "**	0.38	N	0	N
	7/13/00	**14 - 16 "**	0.8	N	0.08	N
	7/18/00	**16 - 26 "**	0.76	N	0.02	N
	7/26/00	**26 - 28 "**	3.46	***	0.12	N
	7/31/00	**16 - 30**	1.26	N	0	N
	8/18/00	**6"**	0.28	N	0.36	N
	8/25/00	**8 - 10"**	0.08	N	0	N
	8/30/00	**9 - 14"**	0	N	0	N
First Production Year Trial (planted 5/3/99)						
	7/5/00	**8 - 12 "**	0.48	**N**	0.02	**N**
	7/13/00	**10 - 12 "**	0.64	**N**	0.2	**N**
	7/18/00	**20 "**	0.52	**N**	0.02	**N**
	7/26/00	**26 - 28 "**	2.44	**Y**	0.02	**N**
	7/31/00	**28 - 36"**	1.28	**N**	0	**N**
	8/18/00	**10-12"**	0.28	**N**	0.32	**N**
	8/25/00	**12"**	0.02	**N**	0	**N**
	8/30/00	**12 - 18"**	0.1	**N**	0.06	**N**

*** 7/26/00. No spray - replication 5 and 8 (27 and 3.2 PLH / sweep respectively, above threshold), all other replications below threshold: No spray (1.2, 1.6, 1.6 PLH / sweep) Spray (0, 1.2, 0, 0, 0 PLH / sweep). Potato leafhopper threshold for alfalfa 11 to 14 inches and greater, $\geq$2.0 PLH / sweep = over threshold.

Table 2: First production year yield and stand notes of the spray/no spray trial planted May 3, 1999 in Ithaca, Tompkins County, NY.

	2000 Data		Yield (Tons/Acre at 0% Moisture)									
			19-Jun		1-Aug		22-Sep		Total Season		% Stand 4/14/00	
	Entry (b)	Classification (a)	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray
1	Freedom	R	3.49	2.93	2.44	2.24	1.76	1.68	7.69	6.85	93	94
5	54H69	R	3.67	3.45	2.36	2.39	1.79	1.61	7.83	7.45	93	90
6	DK 121 HG	R	3.41	3.34	2.39	2.42	1.72	1.61	7.52	7.36	93	95
9	Clean Sweep 1000	R	3.51	3.26	2.38	2.31	1.71	1.67	7.61	7.24	97	93
11	DK131HG	R	3.35	3.41	2.36	2.26	1.79	1.63	7.50	7.30	92	93
12	4R37†	R	2.81	3.07	2.39	2.36	1.71	1.72	6.90	7.15	94	95
13	NY9810 A+B†	R	4.31	3.73	1.97	1.82	1.51	1.40	7.79	6.95	91	92
14	ABT 227 LH	R	3.88	3.36	2.37	2.28	1.82	1.61	8.07	7.25	86	96
15	53H81	R	3.43	3.37	2.44	2.52	1.60	1.61	7.47	7.49	91	96
	Avg. of Res. Var.		3.54	3.32	2.34	2.29	1.71	1.61	7.60	7.23	92	94
2	Oneida VR	S	3.37	3.13	2.42	2.24	1.80	1.68	7.59	7.05	96	96
3	9701	S	3.45	3.10	2.58	2.45	1.95	1.73	7.97	7.28	91	94
4	Cimarron SR	S	3.47	3.13	2.43	2.36	1.95	1.88	7.84	7.37	95	95
7	53Q60	S	3.45	2.68	2.41	2.50	1.96	1.96	7.81	7.13	95	93
8	Alfagraze	S	3.52	3.02	2.32	2.29	1.68	1.61	7.52	6.92	96	95
10	Vernal	S	3.85	3.20	2.28	2.29	1.68	1.58	7.81	7.07	95	92
16	5312	S	3.83	3.09	2.45	2.39	1.76	1.77	8.04	7.25	96	94
	Avg. of Sus. Var.		3.56	3.05	2.41	2.36	1.83	1.74	7.80	7.15	95	94
	Average of Spray Treatment		3.55	3.20	2.37	2.32	1.76	1.67	7.69	7.19	93	94
	Spray vs. No Spray (c)		0.35 *		0.05 ns		0.09 *		0.50 ns		1 ns	
	Resistant vs. Susceptible (c)		-0.02 ns	0.27 **	-0.07 ns	-0.07 *	-0.11 **	-0.13 **	-0.20 ns	0.07 ns	-3 **	0 ns
	Res.(no spray) vs. Susc.(spray)(c		-0.24 **		-0.12 *		-0.21 **		-0.57 **		-1 ns	

(a) R = resistant, S = susceptible

(b) 'Entry †' means that the entry is an experimental alfalfa population and is not commercially available.

(c) *, ** = statistically significant at P<0.05 and P<0.01, respectively; ns = not statistically significant.

Spray treatments were applied on the following dates: 6/23/99, 7/13/99, 8/26/99,6/29/00, 7/17/00, 8/21/00.

Table 3: Second production year notes on PLH resistant and susceptible entries of a trial planted 4/30/1998 on New Ketola 14 in Ithaca, Tompkins County, NY.

RN	Entry (d)	PLH Rating(a)	% Stand 14-Apr		Lodging 6/16/00 1=least, 3=most		Lodging 8/7/00 1=least, 4=most		Maturity 8/7/00 1=least, 9=most		PLH damage 8/7/00 1=least, 5=most (b)		Nymph/10 stems 8/7/00	
			Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray
3	ZH 9731 H †	R	95.0	97.0	2.1	1.8	3.4	1.8	6.7	7.0	1.0	1.6	0.0	2.7
8	54H69	R	95.0	94.0	1.8	1.5	2.6	1.2	6.9	6.9	1.0	1.2	0.0	5.7
9	ZH 9747 H †	R	98.0	97.0	2.1	2.4	3.4	2.2	6.6	7.0	1.0	1.8	0.0	6.0
10	DK 131 HG	R	96.0	94.0	2.1	1.8	3.4	1.6	7.0	7.0	1.0	2.0	0.3	2.3
11	DK 121 HG	R	98.0	97.0	2.1	1.7	3.8	1.2	6.9	6.8	1.0	2.3	0.0	4.7
13	CW 72000 †	R	96.0	95.0	2.0	1.7	2.8	1.8	6.8	7.0	1.0	1.6	0.0	3.0
15	Clean Sweep 1000	R	98.9	97.4	1.7	1.7	2.6	1.7	6.8	6.9	1.0	2.4	0.0	5.7
16	3A10 †	R	98.0	97.0	1.6	1.8	2.4	1.2	6.9	7.0	1.0	1.4	0.0	1.7
18	ZH9734 H †	R	96.0	97.0	1.9	2.0	3.2	2.0	7.0	7.0	1.0	2.0	0.3	4.0
20	TMF 4355 LH	R	93.0	94.0	1.7	1.9	3.2	1.6	7.0	7.0	1.0	1.4	0.0	3.0
22	Freedom	R	95.0	98.0	1.7	1.6	3.6	2.2	6.8	7.1	1.0	2.8	0.0	5.0
23	CW 6246 †	R	96.0	95.0	2.3	2.0	2.8	1.2	6.2	6.0	1.0	1.4	0.0	3.0
24	ABT 227 LH	R	97.0	95.0	1.5	1.6	3.0	1.6	6.7	7.0	1.0	2.1	0.0	5.7
	Avg. of Res. Entries		96.3	96.0	1.9	1.8	3.1	1.6	6.8	6.9	1.0	1.8	0.0	4.0
1	Vernal	S	98.0	97.0	2.0	2.0	2.8	2.2	6.5	6.3	1.0	2.5	0.3	2.0
2	Guardsman	S	98.0	99.0	2.0	1.3	3.6	1.6	7.0	7.0	1.0	3.0	0.3	5.7
5	53Q60	S	99.0	99.0	1.5	2.1	3.4	2.6	6.9	6.6	1.0	2.3	0.0	4.0
6	WL 322 HQ	S	99.1	97.7	2.3	2.4	3.4	2.9	6.1	6.9	1.0	2.7	0.0	5.0
7	Oneida VR	S	98.0	99.0	1.7	1.7	2.6	1.2	6.6	6.8	1.0	3.0	0.0	4.7
14	Arrow	S	99.9	99.0	2.0	1.8	3.8	1.8	6.5	7.0	1.0	2.0	0.0	1.7
17	Alfagraze	S	98.9	99.1	1.7	2.5	2.8	2.6	6.9	6.5	1.0	2.4	0.0	4.7
19	Cimarron 3i	S	98.0	99.0	1.5	1.5	2.2	1.2	6.6	6.6	1.0	3.0	0.0	1.3
	Avg of Sus. Entries		98.6	98.6	1.8	1.9	3.1	2.0	6.6	6.7	1.0	2.6	0.1	3.6
	Avg. of Spray Trt.		96.8	96.8	1.9	1.9	3.0	1.7	6.6	6.7	1.0	2.1	0.1	3.8
	Spray Trt(c)		0.0 ns		-0.0 ns		1.3 **		-0.1 ns		-1.1 **		-3.7 *	
	Resistant vs Susceptible (c)		-2.3 **	-2.6 **	0.1 ns	-0.1 ns	0.0 ns	-0.4 **	0.2 *	0.2 **	0.0 ns	-0.8 **	-0.1 ns	0.4 ns
	Res.(no spray) vs Sus.(spray) (c)		-2.6 **		0.0 ns		-1.5 **		0.3 **		0.8 **		3.9 **	

Spray treatments were applied on the following dates: 7/17/98, 8/2/98, 6/23/99, 7/13/99, 8/26/99, 6/29/00, 7/17/00, 8/21/00.

(a) R=resistant; S=susceptible

(b) PLH damage score was: 1= no visible damage, 2= minor stunting and yellowing, 3= 20-40% damage, 4=40-60% damage,5=60-100% damage.

(c) *, ** = statistically significant at P<0.05 and P<0.01, respectively; ns = not statistically significant.

(d) 'Entry †' means that the entry is an experimental alfalfa population and is not commercially available.

0.7393	0.9034	0.0030	0.2720	0.0010	0.0186
0.0001	0.0211	0.0001	0.0001	0.0001	0.7546
0.9290	0.4251	0.0506	0.1738	0.0001	0.7194

Table 4: First and second production year yields of PLH resistant and susceptible entries of a trial planted 4/30/1998 on New Ketola 14 in Ithaca, Tompkins County, NY.

N	Entry	PLH Rating(a)		16-Jun		7-Aug		22-Sep		2000 Total		1999 Total		2-Yr. Total	
				Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray
3	ZH 9731 H †	R	ABI	2.28	2.38	2.34	2.31	1.02	0.93	5.64	5.62	4.52	4.13	10.16	9.76
8	54H69	R	Pioneer	2.32	2.25	2.37	2.32	1.01	0.96	5.70	5.53	4.71	4.22	10.42	9.75
9	ZH 9747 H †	R	ABI	2.39	2.51	2.36	2.52	0.93	0.98	5.69	6.01	4.28	4.22	9.96	10.23
0	DK 131 HG	R	DEKALB	2.44	2.22	2.28	2.18	1.05	0.97	5.77	5.37	4.64	3.92	10.40	9.29
1	DK 121 HG	R	DEKALB	2.43	2.36	2.28	2.01	1.07	0.91	5.78	5.27	4.71	4.30	10.49	9.57
3	CW 72000 †	R	Cal/West	2.56	2.47	2.26	2.36	0.92	0.90	5.74	5.73	4.86	4.21	10.60	9.94
5	Clean Sweep 100(	R	Agway	2.49	2.41	2.35	2.42	1.07	1.01	5.91	5.84	4.89	4.49	10.81	10.32
6	3A10 †	R	Forage Genetics	2.39	2.17	2.19	2.26	0.98	0.95	5.56	5.38	4.71	4.23	10.26	9.61
8	ZH9734 H †	R	ABI	2.30	2.47	2.33	2.41	1.01	0.98	5.64	5.86	4.71	4.38	10.35	10.23
0	TMF 4355 LH	R	Mycogen	2.32	2.42	2.35	2.40	0.98	0.94	5.65	5.76	4.62	3.76	10.27	9.52
2	Freedom	R	Seedway	2.33	2.35	2.30	2.40	1.04	0.99	5.67	5.74	4.95	4.37	10.61	10.11
3	CW 6246 †	R	Cal/West	2.25	2.22	2.00	2.00	0.90	0.77	5.15	5.00	4.52	3.78	9.67	8.78
4	ABT 227 LH	R	B H (WL)	2.35	2.37	2.16	2.33	1.02	1.00	5.53	5.70	4.60	4.39	10.13	10.09
	Average of Resistant Varieties			2.37	2.35	2.27	2.30	1.00	0.95	5.65	5.60	4.67	4.19	10.32	9.79
	Vernal	S	zcheck	2.50	2.49	2.33	2.17	1.08	0.89	5.90	5.55	4.98	4.18	10.88	9.73
2	Guardsman	S	zcheck	2.47	2.35	2.60	2.37	1.09	0.99	6.16	5.72	4.91	4.07	11.08	9.79
5	53Q60	S	Pioneer	2.45	2.35	2.39	2.62	1.08	1.03	5.93	6.00	5.07	4.45	10.99	10.45
5	WL 322 HQ	S	zcheck	2.19	2.24	2.24	2.36	1.09	1.05	5.52	5.65	4.64	4.21	10.16	9.86
7	Oneida VR	S	zcheck	2.34	2.20	2.14	2.29	1.05	0.91	5.52	5.40	4.88	4.03	10.40	9.43
4	Arrow	S	zcheck	2.54	2.63	2.55	2.52	1.12	1.09	6.20	6.24	4.60	4.98	10.80	11.22
7	Alfagraze	S	zcheck	2.30	2.75	1.85	2.44	0.92	0.97	5.08	6.16	4.19	4.33	9.28	10.49
9	Cimarron 3i	S	GPR	2.41	2.28	2.09	2.21	1.02	0.96	5.52	5.45	4.78	3.99	10.30	9.44
	Average of Susceptible Varieties			2.40	2.41	2.27	2.37	1.06	0.99	5.73	5.77	4.76	4.28	10.48	10.05
	Average of Spray Treatment			2.38	2.38	2.27	2.33	1.02	0.96	5.68	5.67	4.70	4.22	10.38	9.89
	Spray Trt(c)			0.00 ns		-0.06 ns		0.06 ns		0.01 ns		-0.48 *		0.49 ns	
	Resistant vs Susceptible (c)			-0.03 ns	-0.06 ns	0.00 ns	-0.07 ns	-0.06 **	-0.04 *	-0.08 ns	-0.17 *	-0.08 ns	-0.09 ns	-0.17 ns	-0.26 ns
	Res. (not sprayed) vs Sus. (sprayed) (c)			-0.04 ns		0.02 ns		-0.11 **		-0.13 ns		-0.58 **		-0.72 **	

Spray treatments were applied on the following dates: 7/17/98, 8/2/98, 6/23/99, 7/13/99, 8/26/99, 6/29/00, 7/17/00, 8/21/00.

(a) R=resistant; S=susceptible

(c) *, ** = statistically significant at P<0.05 and P<0.01, respectively; ns = not statistically significant.

(d) 'Entry †' means that the entry is an experimental alfalfa population and is not commercially available.

p-values						
trt	0.9110	0.6375	0.2822	0.9534	0.0436	0.2416
entry	0.0001	0.0002	0.0001	0.0001	0.2734	0.0065
try x entry	0.0023	0.2217	0.3718	0.0337	0.4457	0.1787

Table 5: Second production year forage quality of PLH resistant and susceptible entries of a trial planted 4/30/1998 on New Ketola 14 in Ithaca, Tompkins County, NY.

			Forage Quality Component (b)													
		Classifi-	% Crude Protein		% ADF		% NDF		RFV		$/ton		Yield H2 (t/a)		$/acre	
RN	Entry (d)	cation (a)	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray	Spray	No Spray
3	ZH 9731 H †	R	20.2	18.1	34.5	35.1	44.3	44.4	130.4	128.8	124.76	117.52	2.5	2.4	303.98	279.39
8	54H69	R	19.2	19.5	35.1	34.0	44.2	43.2	129.6	134.5	121.57	123.86	2.4	2.3	294.43	287.02
9	ZH 9747 H †	R	19.0	18.2	36.3	34.9	45.4	44.5	124.6	128.9	119.01	117.74	2.5	2.5	301.42	299.55
10	DK 131 HG	R	19.1	19.1	36.0	33.5	45.2	42.5	125.4	137.6	119.53	123.46	2.3	2.0	273.34	247.71
11	DK 121 HG	R	18.9	18.1	37.3	35.5	47.2	44.5	118.2	128.0	116.08	117.25	2.3	2.1	267.91	244.27
13	CW 72000 †	R	19.9	20.0	36.0	33.8	46.0	43.9	123.2	132.6	121.07	124.72	2.1	2.1	254.39	264.40
15	Clean Sweep 1000	R	20.4	17.8	34.9	35.3	44.0	44.4	130.6	128.4	125.49	116.34	2.3	2.3	290.41	266.78
16	3A10 †	R	20.9	19.2	34.9	35.9	45.4	46.4	126.6	122.3	125.68	117.97	2.1	2.2	261.24	264.29
18	ZH9734 H †	R	20.9	18.8	33.3	34.4	43.3	43.5	135.4	132.7	128.90	120.88	2.2	2.3	276.21	284.01
20	TMF 4355 LH	R	19.8	18.6	36.3	34.9	46.0	44.0	122.8	130.3	120.81	119.42	2.4	2.2	284.30	262.31
22	Freedom	R	19.9	18.7	36.1	34.8	46.1	44.5	123.0	129.4	121.08	119.36	2.2	2.2	269.49	262.16
23	CW 6246 †	R	20.8	19.9	34.3	32.8	44.2	42.2	130.9	139.5	127.00	126.84	1.9	1.9	244.79	234.88
24	ABT 227 LH	R	20.0	18.6	34.9	35.3	44.4	44.8	129.6	127.8	124.04	118.32	2.1	2.4	264.41	283.26
	Avg. of Res. Entries		19.9	18.8	35.4	34.6	45.0	44.1	126.9	130.8	122.69	120.28	2.3	2.2	275.87	267.69
1	Vernal	S	18.7	18.2	36.8	34.8	46.5	44.1	120.5	130.5	116.48	118.37	2.4	2.1	273.81	247.14
2	Guardsman	S	19.3	17.8	36.4	33.7	46.8	42.5	121.4	137.3	118.32	119.13	2.4	2.4	285.29	286.34
5	53Q60	S	19.7	17.1	35.5	34.9	45.0	43.5	126.9	131.9	121.96	115.49	2.4	2.4	293.88	279.66
6	WL 322 HQ	S	20.9	18.5	34.1	34.0	43.4	42.9	133.9	135.1	128.38	120.76	2.0	2.2	253.77	269.69
7	Oneida VR	S	19.5	17.7	35.1	34.9	44.6	44.0	128.6	130.4	122.09	116.76	2.1	2.3	251.47	269.63
14	Arrow	S	19.1	18.3	36.2	35.3	45.8	44.4	123.2	128.6	118.74	117.84	2.4	2.5	280.84	291.40
17	Alfagraze	S	19.9	17.9	35.3	35.2	45.4	44.9	126.0	127.5	122.29	116.31	2.0	2.4	241.42	278.01
19	Cimarron 3i	S	18.9	19.3	36.4	32.6	45.6	42.5	123.5	139.2	118.44	124.59	2.0	2.1	239.03	257.42
	Avg. of Sus. Entries		19.5	18.1	35.7	34.4	45.4	43.6	125.5	132.6	120.84	118.66	2.2	2.3	264.94	272.41
	Avg. of Spray Trt.		19.8	18.6	35.5	34.6	45.2	43.9	126.4	131.5	121.98	119.66	2.2	2.3	271.71	269.49
	Spray Trt (c)		1.1 ns		0.9 ns		1.3 ns		-5.1 ns		1.43 ns		0.0 ns		2.23 ns	
	Resistant vs. Susceptible (c)		0.4 *	0.7 **	-0.3 ns	0.2 ns	-0.3 ns	0.5 ns	1.4 ns	-1.7 ns	1.86 ns	1.63 ns	0.1 ns	-0.1 ns	11.0 ns	-4.72 ns
	Res.(no spray) vs Sus.(spray) (c)		-0.7 **		-1.1 *		-1.3 **		5.3 *		-0.55 ns		0.0 ns		2.75 ns	

Spray treatments were applied on the following dates: 7/17/98, 8/2/98, 6/23/99, 7/13/99, 8/26/99, 6/29/00, 7/17/00, 8/21/00.

(a) R=resistant; S=susceptible

(b)ADF = acid detergent fiber, NDF = neutral detergent fiber, RFV = relative feed value, $/ton = estimates of forage value from FORVAL model (Wilkens and Fick, 1988) when corn grain is valued at $2.69/bu, and soybean meal is valued at $210/ton.

(c) *, ** = statistically significant at P<0.05 and P<0.01, respectively; ns = not statistically significant.

(d) 'Entry †' means that the entry is an experimental alfalfa population and is not commercially available.

Appendix 1**.** PLH data from individual alfalfa cultivars from one replication (replication 5, 13.5 x's over threshold) showing evidence of PLH damage. All other replications well below threshold.

7/31/2000 - N. Ketola, 1998 PLH Plots, Alfalfa stunted and PLH damage quite evident. Rep 5 data presented - yellow and stunted alfalfa typical, *read plots north to south*, Rep 5 is the western most rep on northern end, lies adjacent to access road.

Cultivar	Plant Height	Average PLH / sweep	Over Threshold?
Oneida VR	**20**	4.2	Y
WL322 HQ	**20**	8.6	Y
Vernal	**19**	3.8	Y
TMF 4355 LH	**24**	3.0	Y
NY 9722	**19**	2.8	Y
Cleansweep 1000	**21**	5.4	Y
ZH 9747 H	**30**	4.2	Y
NY 9719	**22**	4.8	Y
Alfagraze	**24**	4.0	Y
ZH 9731 H	**22**	2.6	Y
DK 121 HG	**24**	2.0	Y
Arrow	**21**	6.6	Y
Oneida VR	**24**	7.6	Y
53Q60	**20**	5.8	Y
3A10	**24**	1.8	**N**
Cimarron 3I	**14**	9.0	Y
CW 6246	**19**	1.0	**N**
DK 131 HG	**17**	3.2	Y
Freedom	**21**	3.6	Y
ABT 227LH	**18**	3.4	Y
CW 72000	**22**	0.2	**N**
54H69	**28**	2.8	Y
Guardsman	**22**	9.8	Y
NY 9721	**11**	2.2	Y
ZH 9734H	**21**	2.2	Y
Oneida VR	**20**	3.8	Y
Avg.	**21**	4.2	

If alfalfa height is 11 to 14 inches and greater, $\geq$2.0 PLH / sweep = over threshold